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CLOTHES DRYER

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[There are no amendments to this patent.]

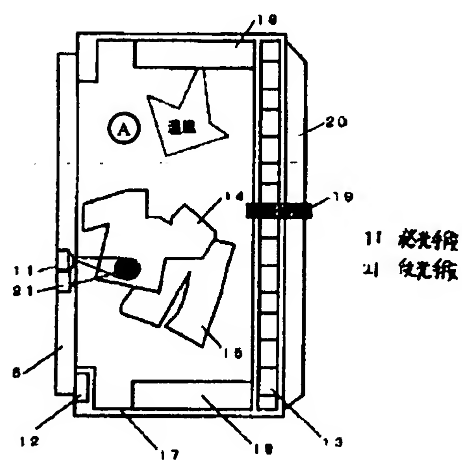
Abstract

Problem

For a conventional constitution of a clothes dryer, the principle of measurement of water content is that the absolute value of the water content of the object for detection while not moving is only measured at one time point, and, when it is adopted in detecting the completion of drying of the clothes dryer, etc., the constitution is complicated and the price is high. This is undesired.

Constitution

A type of clothes dryer characterized by the fact that detection is performed by means of variation of the light-receiving output of light-receiving means (21) over time, so that with only a single light-receiving means, it is possible to judge the desired time until completion of drying and for a prescribed dryness as well as the clothes quantity.



Key: 11 Light-emitting means
12 Light-receiving means
A Warm air

Claims

1. A type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and that controls the operation of the

clothes dryer; and, by means of said control means, the dryness of said object to be dried is judged from the variation rate over time of said light-receiving output.

2. A type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and that controls the operation of the clothes dryer; and, by means of said control means, the clothing quantity as said object to be dried is judged from said light-receiving output by said control means.

3. A type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and that controls the operation of the clothes dryer; and the operation is controlled based on the operation time determined from the dispersion value and average value of said light-receiving output.

4. A type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and that controls the operation of the clothes dryer; and the clothing quantity as said object to be dried is judged based on the dispersion value and average value of said light-receiving output.

5. A type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, a temperature measurement means that measures the temperature in the barrel of the clothes dryer, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and computes the temperature by said temperature measurement means, and controls the operation of the clothes dryer; and the operation is controlled based on the operation time determined from said light-receiving output and said temperature output with said control means.

6. A type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, a temperature measurement means that measures the temperature in the barrel of the clothes dryer, and a control means that controls

ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and computes the temperature by said temperature measurement means, and controls the operation of the clothes dryer; and the clothing quantity as said object to be dried is judged from said light-receiving output and said temperature output with said control means.

7. The clothes dryer described in any of Claims 1-6 characterized by the fact that as the light-receiving output compared with the control means, a sub-sampling value of the maximum value of said light-receiving output in a certain time range is used as the representative value of said certain time range.

8. The clothes dryer described in any of Claims 1-6 characterized by the fact that as the light-receiving output compared with the control means, a sub-sampling value is used of the average value of said light-receiving output in a certain time range as the representative value in said certain time range.

9. The clothes dryer described in any of Claims 1-6 characterized by the fact that as the light-receiving output compared with the control means, the moving average value of the light-receiving output and the typical value in a certain time range are used.

10. The clothes dryer described in any of Claims 2-6 characterized by the fact that fuzzy inference is adopted in the computation for determining the operation time or for judgment of the clothes quantity in the control means.

11. The clothes dryer described in any of Claims 1-6 characterized by the fact that as the time point of sampling of the light-receiving output by the control means, using the control means, the operation is stopped and, while the clothes are not moving, said sampling is performed, or sampling is performed at a prescribed time interval in synchronization with the rotation velocity of the drum.

12. The clothes dryer described in any of Claims 1-6 characterized by the fact that as the light-receiving output compared with the control means, the value of the light-receiving output or representative value in a certain time range variation is corrected for variation in the light-receiving and light-emitting sensitivity, such as from the temperature characteristics, etc., of the light-emitting means and light-receiving means, by using the minimum value in said certain time range.

13. The clothes dryer described in any of Claims 1-6 characterized by the following facts: one or several temperature measurement means are present for measuring a temperature correlated to the temperature of the light-emitting means or light-receiving means; and, as the light-receiving output computed with the control means, the value obtained by temperature correction using the temperature output measured with said one or several temperature measurement means is used.

14. The clothes dryer described in any of Claims 1-6 characterized by the following facts: a light-receiving means for correction is set that obtains a corrected light-receiving output according to the quantity of light received of the reflected light from direct light other than from the object to be dried on which [object] as the light-receiving means the light from the same light-emitting means is projected, and, as the light-receiving output compared with the control means, the value obtained by correction for variation in the light-receiving and light-emitting sensitivity, such as from the temperature characteristics, etc., of the light-emitting means and light-receiving means, with said corrected light-receiving output is used.

15. The clothes dryer described in any of Claims 1-14 characterized by the fact that as the condition for the case computation of the maximum value, average value, minimum value, or moving average value, the condition should be met of the value being lower than a prescribed upper limit value and/or the value being over a prescribed lower limit value.

Detailed explanation of the invention

[0001]

Technical field of the present invention

The present invention pertains to a dryness detection system characterized by the fact that the water content of an object to be dried is measured by means of variation in the reflected light caused by water content in the object. It can be used widely as a dryness sensor and clothes quantity sensor of clothes driers.

[0002]

Prior art

In the prior art, it is well known that the water content of an object to be dried can attenuate reflected light due to absorption of IR light at wavelengths characteristic of each substance and due to variation in the refractive index and the scattering state from the water content attached on the surface of the fibers. By exploiting this phenomenon, it is possible to detect the water content of the object to be dried by projecting light onto the object to be dried and detecting variation in the reflected light.

[0003]

With said phenomena, especially, the phenomenon of absorption of IR light has been adopted in practical application in measurements units, such as water content meters, spectroscopic analyzers, etc. Because IR light absorptivity depends on the absolute value of the water content in the object to be dried, the difference in absorptivity between a wavelength that is absorbed by water and a wavelength free of absorption by water is detected.

[0004]

Problems to be solved by the invention

Regarding the constitution of said measurement devices in practical application, the objective is to measure the absolute water content in the object to be dried at certain time point. Since the detection principle involves a non-moving object as the measurement subject, when the object is clothes in motion while the water content in the clothes in a clothes dryer is detected, it is necessary to add certain structure and signal processing for correction of the facing angle of the clothes and the orientation of the clothes.

[0005]

As opposed to the conventional scheme with the absolute quantity of water in the object for detection detected only at one time point, in the present system, a simple and inexpensive constitution is realized when the system is adopted in a clothes dryer or the like. According to this system, it is possible to continuously observe the variation in the light-receiving output over time from before the operation to the completion of drying, and, it is possible to detect the drying completion time when there is no variation in the light-receiving output over time and to estimate the clothes quantity from the relative light-receiving output at the start of operation.

[0006]

Means to solve the problems

In order to realize the aforementioned objective, according to the present invention, the system has a light-emitting means that projects light toward the object to be dried, a light-receiving means that receives the light reflected from the object to be dried, and a control means that controls ON/OFF of said light-emitting means, computes the light-receiving output according to the quantity of light received from said light-receiving means and that controls operation of the clothes dryer. By means of said control means, from the variation rate of said light-receiving output over time, the dryness of said object to be dried and the clothes quantity can be judged, and the operation can be controlled.

[0007]

Embodiment of the present invention

The invention described in Claim 1 of the present patent application provides a type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, and a control means that controls ON/OFF of said light-

emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and that controls the operation of the clothes dryer; and, by means of said control means, the dryness of said object to be dried is judged from the variation rate over time of said light-receiving output.

[0008]

The invention described in Claim 2 of the present patent application provides a type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and that controls the operation of the clothes dryer; and, by said control means, the clothing quantity as said object to be dried is judged from said light-receiving output by said control means.

[0009]

The invention described in Claim 3 of the present patent application provides a type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and that controls the operation of the clothes dryer; and the operation is controlled based on the operation time determined from the dispersion value and average value of said light-receiving output.

[0010]

The invention described in Claim 4 of the present patent application provides a type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and that controls the operation of the clothes dryer; and the clothing quantity as said object to be dried is judged based on the dispersion value and average value of said light-receiving output.

[0011]

The invention described in Claim 5 of the present patent application provides a type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, a temperature measurement means that measures the temperature in the barrel of the clothes dryer, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and computes the temperature by said temperature measurement means, and controls the operation of the clothes dryer; and the operation is controlled based on the operation time determined from said light-receiving output and said temperature output with said control means.

[0012]

The invention described in Claim 6 of the present patent application provides a type of clothes dryer characterized by the following facts: the clothes dryer has a light-emitting means that projects light on an object to be dried, a light-receiving means for receiving the reflected light from said object to be dried, a temperature measurement means that measures the temperature in the barrel of the clothes dryer, and a control means that controls ON/OFF of said light-emitting means and computes the light-receiving output according to the quantity of light received from said light-receiving means and computes the temperature by said temperature measurement means, and controls the operation of the clothes dryer; and the clothing quantity as said object to be dried is judged from said light-receiving output and said temperature output with said control means.

[0013]

The invention described in Claim 7 of the present patent application pertains to the clothes dryer described in any of Claims 1-6 characterized by the fact that as the light-receiving output compared with the control means, a sub-sampling value is used of the maximum value of said light-receiving output in a certain time range as the representative value of said certain time range. As a result, operation is controlled with even higher precision.

[0014]

The invention described in Claim 8 of the present patent application pertains to the clothes dryer described in any of Claims 1-6 characterized by the fact that as the light-receiving output compared with the control means, a sub-sampling value is used of the average value of

said light-receiving output in a certain time range as the representative value in said certain time range. As a result, operation is controlled with even higher precision.

[0015]

The invention described in Claim 9 of the present patent application pertains to the clothes dryer described in any of Claims 1-6 characterized by the fact that as the light-receiving output compared with the control means, the moving average value of the light-receiving output and the typical value in a certain time range are used. As a result, operation is controlled with even higher precision.

[0016]

The invention described in Claim 10 of the present patent application pertains to the clothes dryer described in any of Claims 2-6 characterized by the fact that fuzzy inference is adopted in the computing for determining the operation time or for judgment of the clothes quantity in the control means. As a result, operation is controlled with even higher precision.

[0017]

The invention described in Claim 11 of the present patent application pertains to the clothes dryer described in any of Claims 1-6 characterized by the fact that as the time point of sampling of the light-receiving output by the control means, using the control means, the operation is stopped and, while the clothes are not moving, said sampling is performed, or sampling is performed at a prescribed time interval in synchronization with the rotation velocity of the drum. As a result, operation is controlled with even higher precision.

[0018]

The invention described in Claim 12 of the present patent application pertains to the clothes dryer described in any of Claims 1-6 characterized by the fact that as the light-receiving output compared with the control means, the value of the light-receiving output or representative value in a certain time range is corrected for variation in the light-receiving and light-emitting sensitivity, such as from the temperature characteristics, etc., of the light-emitting means and light-receiving means, by using the minimum value in said certain time range. As a result, operation is controlled with even higher precision.

[0019]

The invention described in Claim 13 of the present patent application pertains to the clothes dryer described in any of Claims 1-6 characterized by the following facts: one or several

temperature measurement means are present for measuring a temperature correlated to the temperature of the light-emitting means or light-receiving means; and, as the light-receiving output compared with the control means, the value obtained by temperature correction using the temperature output measured with said one or several temperature measurement means is used. As a result, operation is controlled with even higher precision.

[0020]

The invention described in Claim 14 of the present patent application pertains to the clothes dryer described in any of Claims 1-6 characterized by the following facts: a light-receiving means for correction is set that obtains a corrected light-receiving output according to the quantity of light received from the reflected light or direct light from other than the object to be dried on which [objects] as the light-receiving means the light from the same light-emitting means is projected, and, as the light-receiving output compared with the control means, the value obtained by correction for variation in the light-receiving and light-emitting sensitivity, such as from the temperature characteristics, etc., of the light-emitting means and light-receiving means, with said corrected light-receiving output is used. As a result, operation is controlled with even higher precision.

[0021]

The invention described in Claim 15 of the present patent application pertains to the clothes dryer described in any of Claims 1-14 characterized by the fact that as the condition for the case of computation of the maximum value, average value, minimum value, or moving average value, the condition of the value being lower than a prescribed upper limit value and/or the value being over a prescribed lower limit value should be met. As a result, operation is controlled with even higher precision.

[0022]

For the constitution of said inventions, the value of the water content in the clothes while in constant movement can be determined instantly at high precision with a simple constitution.

[0023]

Application examples

In the following, the present invention will be explained in more detail with reference to an application example with reference to figures.

[0024]

Figure 1 is a diagram illustrating the constitution with the dryness detecting system for a clothes dryer of this application example incorporated in it. This clothes dryer is a drum-type dryer of a warm air blowing system. (11) represents a light-emitting means made of an LED, miniature light bulb or another light source that projects visible light or IR light (hereinafter to be referred to as light) on clothes in the drum. The light projected by light-emitting means (11) is incident on clothes (14), (15) in drum (17) and is reflected from them and received by light-receiving means (21). The detection signal of light-receiving means (21) is transmitted to a control board having control means (12) attached on it.

[0025]

(20) represents the front door for loading of clothes, and (18) represents a baffle for blowing warm air into drum (17). Usually, baffles are set at plural sites. (19) represents a rotating shaft supporting drum (17) for rotation, and (13) represents a cooling fan for heat exchange.

[0026]

Figure 1 is a diagram illustrating positions for attaching light-emitting means (11) and light-receiving means (21). Figure 1 shows the case when attachment is performed on the interior of the cover. However, the present invention is not limited to this scheme. One may also adopt the following methods: in one method, they are integrated with control board (12) for attachment; in another method, said light-emitting means (11) and light-receiving means (21) are separated from each other for attachment.

[0027]

Figure 2 is a diagram illustrating the qualitative relationship between the dryness of clothes and the output when the reflected light is received by the light-receiving element. In Figure 2, the abscissa indicates the dryness, and the ordinate indicates the relative light-receiving output V when the reflected light is received by light-receiving means (21). As can be seen from Figure 2, the higher the dryness of the clothes, the larger the reflected light quantity, and the curve runs upward to the right. However, since the slope of the graph shown in Figure 2 varies as a function of such factors as material and color of the clothes, surface treatment degree, knitting scheme of fibers, etc., the ordinate does not show the absolute light-receiving output. Instead, it shows the relative value normalized for each type of clothes.

[0028]

Figure 3 is a diagram illustrating qualitative variation over time of the light-receiving output when the clothes dryer shown in Figure 1 is actually in operation. In Figure 3, the abscissa indicates the operation elapsed time T, and the ordinate indicates the relative light-receiving output V when the reflected light is received by light-receiving means (21). In practical operation, the clothes are rotated by the drum and the reflection distance continually varies. As a result, the obtained signal indicates that the light-receiving output varies. Figure 3 shows the qualitative trend as a result of smoothing the signal, such as averaging the signal.

[0029]

As shown in Figure 3, as the operation continues and drying makes progress, relative light-receiving output V increases. Then, as drying makes further progress, a constant-rate drying period with a constant evaporation rate is entered, followed by a period in which the variation gradually decreases. Finally, the output levels-off and no more variation takes place, and drying comes to an end. Consequently, the detected time point at which there is no variation in relative light-receiving output V over time, can be taken as the drying-completion time point. Also, the completion of drying may also be judged by checking the degree of decrease in dV/dT, the variation rate of the relative light-receiving output with respect to time.

[0030]

As explained above, in the present application example, a conventional scheme composed of plural light-receiving means at different wavelengths for detecting the absolute water content, such as the structure adopted in a water content meter of the prior art, is not adopted. Instead, the detection of the time point of completion of drying by the clothes dryer by adopting a simple constitution composed of only a single wavelength light-receiving means (21) is the focus. In this method, the constitution is simple, the number of parts is small, and the cost can be cut significantly for commercially available products. As a result, a significant effect for practical application as a general home product is obtained.

[0031]

Figure 4 is a diagram illustrating the characteristics with respect to distance of reflected light for clothes at a prescribed dryness. In Figure 4, the abscissa represents distance D between the clothes and the light-receiving means, and the ordinate represents relative light-receiving output V. As shown in Figure 4, when distance $D=d_1$, $V=V_1$ is output, and, at a longer distance $D=d_2$, $V=V_2$ is output, and at a shorter distance $D=d_0$, $V=V_0$ is output. It can be seen that for the

distance characteristics of relative light-receiving output V, usually, the relative light-receiving output falls reciprocally proportionally to the square of distance D.

[0032]

In the following, an explanation will be given regarding an application example of detection of the clothes quantity and estimation of the initial dryness as shown in Figures 5 and 6 based on the distance characteristics shown in Figure 4. Figure 5 is a histogram illustrating a rank distribution at relative light-receiving output V. In Figure 5, (51) shows a histogram for a small quantity of clothes, and (52) and (53) correspond to an intermediate clothes quantity and large clothes quantity, respectively. It can be seen that the larger the clothes quantity, the smaller the distance of reflection, so that the frequency in obtaining a higher relative light-receiving output is higher. On the other hand, the smaller the clothes quantity, the larger the distance of reflection, so that the frequency [in obtaining a higher relative light-receiving output] is lower.

[0033]

That is, by judging the state of the histogram output, one can judge the clothes quantity. In the following, as an example of the signal processing method, an explanation will be given regarding the method of computation of the dispersion value for judging said histograms (51)-(53). Said histogram (51) [sic; (53)] corresponds to a larger clothes quantity, so that the dispersion value is larger. On the other hand, when the clothes quantity is smaller, the dispersion value of the corresponding histogram decreases. Consequently, by computing the dispersion value of the output value of the sensor sampled by control means (12), one can judge the clothes quantity.

[0034]

In the following, histograms corresponding to different dryness values for the same clothes quantity will be shown in Figure 6. In Figure 6, (61) represents a histogram of dry clothes; (62) represents a histogram of the same clothes with a certain wetness; and (63) represents a histogram of the same clothes with a higher water content. Histograms for the same clothes quantity have essentially the same distributional shape.

[0035]

As shown in Figure 2, water content attenuates the reflected light, so that the lower the dryness, the lower the peaks on the histogram. Consequently, by reading the shapes of histograms (61)-(63), one can judge the water content of the clothes. As an example of a signal processing method for judging said histograms (61)-(63), one can compute the area of the histogram or the average value obtained by dividing the area by the total frequency number.

[0036]

That is, for clothes with higher dryness, the average value is larger, and, on the other hand, for clothes with lower dryness, the average value is larger [sic; smaller]. Consequently, by computing the dispersion value of the light-receiving output value that has been sampled by means of control means (12), one can judge the dryness of the clothes.

[0037]

As explained above with reference to Figures 5-6, the dispersion value of the histogram can be correlated with the clothes quantity, and the average value can be correlated with the dryness of the clothes. Consequently, by means of said two computed values, one can judge the clothes quantity and the dryness of the clothes. Usually, for a clothes dryer, if the clothes quantity and the dryness before operation are the same, the time needed for drying to a prescribed dryness and the time needed for completion of drying are nearly constant.

[0038]

Consequently, one may also adopt a scheme in which a preparatory experiment is performed to measure the time needed for each of several combinations of clothes quantity and dryness using the clothes dryer, and a table is prepared with the dispersion value and average value of the histogram of the sensor output as input and with the necessary time as the output value. By means of this scheme, it is possible to predict the time needed for a prescribed dryness and the time needed for completion of drying at the beginning of operation.

[0039]

By incorporating this method in control means (12), various controls for the operation of the clothes dryer can be used, such as a control with which the rotation velocity of the drum is changed or the warm air heater is turned OFF after a prescribed period of time required for the prescribed dryness, and a control with which the operation is turned OFF at a prescribed required for completion of the drying operation.

[0040]

In addition, fuzzy inference is well known as a means for improving the precision of a control method in computing the output value from plural input values. Consequently, the use of fuzzy inference as the computing means is quite effective in computing a single output of the desired time from two inputs, that is, the dispersion value and the average value, by adopting the

combination of the clothes quantity and the initial dryness prepared for various cases as adopted by the user in the present application example.

[0041]

In the following, an explanation will be given regarding a method using the rise rate of the temperature in the barrel over time as a method for judging the clothes quantity and the initial dryness as shown in Figure 7. The rise rate of the temperature in the barrel over time is corrected for both the clothes quantity and the initial dryness. In Figure 7, the abscissa indicates the rise rate, and the ordinate on the left indicates the clothes quantity for a constant dryness, while the ordinate on the right indicates the initial dryness for a constant clothes quantity.

[0042]

As shown in Figure 7, with a constant clothes quantity, the lower the initial dryness, the smaller the rate of rise of the temperature in the barrel over time, and, on the other hand, the higher the initial dryness, the larger the rate of rise of the temperature in the barrel over time. On the other hand, at a constant dryness, the larger the clothes quantity, the smaller the rise rate, and, the smaller the clothes quantity, the larger the rise rate.

[0043]

As explained above, the rise rate of the temperature in the barrel over time is correlated with the clothes quantity and the initial dryness. As a result, one may substitute the temperature rise rate information in place of the average value of a histogram that is correlated with the initial dryness. Consequently, once a table is prepared with the dispersion value and rise rate taken as the input and the required time taken as the output, control of the operation of the clothes dryer is possible. Also, once a table is prepared substituting the temperature rise rate information in place of the dispersion value of the histogram correlated with the clothes quantity, and with the rise rate taken as input of the average value while the required time is taken as the output, control of the operation of the clothes dryer is possible.

[0044]

Finally, an explanation will be provided for an effective method for a clothes dryer for pretreatment of the light-receiving output when the clothes quantity and initial dryness are judged as aforementioned. For a clothes dryer, when the light reflected from the clothes is measured while the clothes are agitated in the drum, the output decreases as the distance between light-receiving means (21) and the clothes increases, as has been explained with reference to the distance characteristics shown in Figure 4.

[0045]

As a scheme for improvement in this respect, the following method may be adopted: a prescribed time is set, and the maximum [reflection] value within this time is extracted by performing sub-sampling, so that only the light-receiving output when reflection is performed for clothes at the nearest position is used in the computing operation.

[0046]

As another scheme for improvement, a prescribed time range is set, and an average value is set within this time, so that the light-receiving output corresponding to the light-receiving output with reflection at the average distance while the clothes move within the prescribed time range is used in computing.

[0047]

In addition, as a phenomenon characteristic of the clothes dryer, when the clothes are agitated in the drum, the clothes in the deeper portion of the drum take a longer time to appear on the front side. In the system of the present invention, since the light of the light-emitting means cannot reach the clothes in the deeper portion, the clothes in that portion cannot be detected directly, so that either one should wait for the clothes to appear on the front side or a means should be employed to estimate their dryness from the clothes on the front side. As a method for realizing this scheme, computing is performed using a moving average value in a prescribed time range, and a representative value indicating the average dryness of all the clothes in the barrel is used for judgment.

[0048]

Also, when the light-emitting means and light-receiving means are attached on the clothes dryer, the light-receiving output varies due to variation factors, such as the temperature characteristics and variation over time of the light-emitting element and light-receiving element, as well as scratches or dirt on the window material that covers the light-emitting element and light-receiving element. In order to correct for such variation factors, one may adopt a method of correction using the minimum value in a prescribed time. The minimum value in a prescribed time is the light-receiving output corresponding to an offset when light is not incident from the light-emitting means on the clothes. Consequently, the minimum value is usually constant, and variation takes place only due to the influence of variation factors. Consequently, it is possible to correct for variation factors using a method of normalization with said minimum value.

C

[0049]

Also, as a means for accurately correcting the temperature characteristics among the various variation factors, one may adopt a constitution in which a temperature sensor for measuring the temperature of the light-emitting means and light-receiving means is added, and correction of the temperature characteristics is performed based on the obtained temperature information.

[0050]

As yet another correcting method, the following scheme may be adopted: when a light-receiving means for correction adopting the constitution of no incident light from clothes is set, variation factors other than the reflected light also have the same influence on the light-receiving means for detection; as a result, the variation means can be corrected by means of normalization using the light-receiving output of said light-receiving means for correction.

[0051]

In the above, an explanation was provided for a drum-type rotating dryer in this application example. However, the present invention may also be adopted in other types of driers, such as a dryer set in a bathtub, a suspended type dryer of the hanger type, etc.

[0052]

Also, there is no specific restriction on the wavelength adopted for light-emitting means (11) and light-receiving means (21). However, light-emitting elements and light-receiving elements with light-receiving sensitivity near 900 nm are used extensively in remote controls for various home products, so they may be used at a very low cost due to mass production. Consequently, when light-receiving elements are used such that the reference light is near 900 nm, the commercial effect is significant.

[0053]

Also, in this application example, the attachment position is on the lower side of the outer side of the drum. However, placement is not limited to this position. In consideration of fact that the air feeding port in the lower portion of the drum is influenced by external disturbances of falling temperature due to air feeding from the air blowing port, another effective scheme is to avoid said site and to use the opposite surface in the direction of the central rotating axis of the drum. Also, by setting the optical path at a position perpendicular to the axis of the drum, when clothes fall to the lower portion of the drum under their own weight, it is possible to radiate light on the clothes at high frequency.

[0054]

Effect of the present invention

According to the present invention with said constitution, it is possible to detect the water content at high reliability even though the object is rotating. Also, the value can be determined in real time. As a result, it is possible to determine the completion of drying of the clothes dryer correctly with a simple constitution.

Brief description of the figures

Figure 1 is a diagram illustrating an application example of a clothes dryer of the present invention.

Figure 2 is a diagram illustrating the relationship between the clothes dryness and the relative light-receiving output of said clothes dryer.

Figure 3 is a diagram illustrating an example of the relative light-receiving output in the drying operation cycle of said clothes dryer.

Figure 4 is a diagram illustrating characteristics of the relative light-receiving output versus the distance between the surface of the light-receiving element and the clothes.

Figure 5 is a diagram illustrating the histogram output of the sensor of a clothes dryer with respect to the clothes quantity.

Figure 6 is a diagram illustrating the histogram output of the sensor of said clothes dryer at various dryness values.

Figure 7 is a diagram illustrating the initial rise rate of temperature in the barrel of said clothes dryer at various values of the dryness.

Explanation of symbols

11 Light-emitting means

21 Light-receiving means

12 Control means

14 Clothes

17 Drum

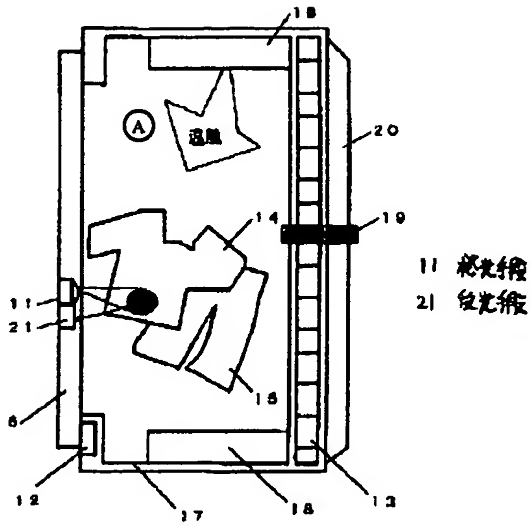


Figure 1

Key: 11 Light-emitting means
21 Light-receiving means
A Warm air

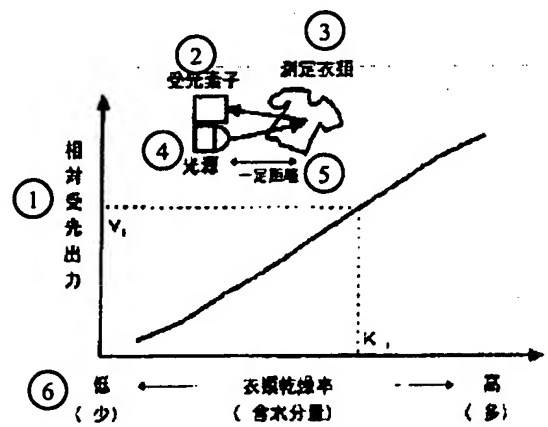


Figure 2

Key: 1 Relative light-receiving output
2 Light-receiving element
3 Clothes under measurement
4 Light source
5 Prescribed distance
6 Lower (smaller) ← Clothes dryness (water content) → Higher (larger)

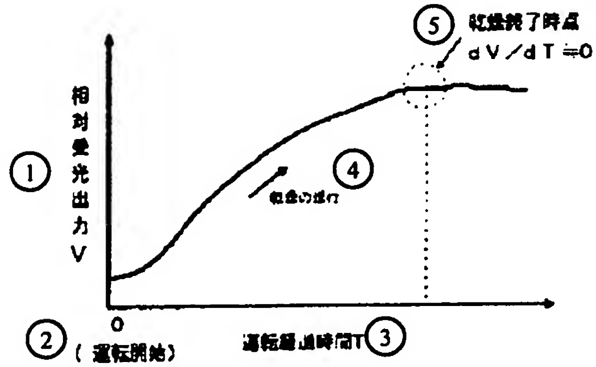


Figure 3

Key:
1 Relative light-receiving output V
2 Start of operation
3 Operation time elapsed T
4 Progress of drying
5 Drying end point

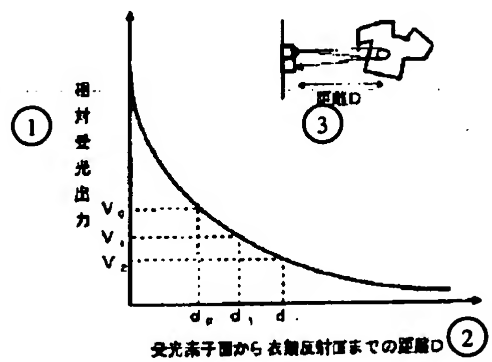


Figure 4

Key:
1 Relative light-receiving output
2 Distance D from surface of light-receiving element to reflective surface of clothes
3 Distance D

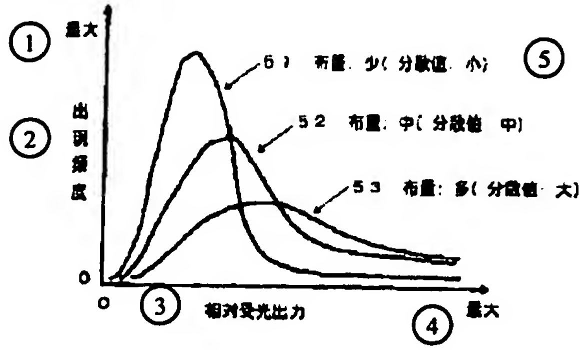


Figure 5

Key:
1 Maximum
2 Appearance frequency
3 Relative light-receiving output
4 Maximum
5 Clothes quantity: smaller (dispersion value: smaller)
Clothes quantity: intermediate (dispersion value: intermediate)
Clothes quantity: larger (dispersion value: larger)

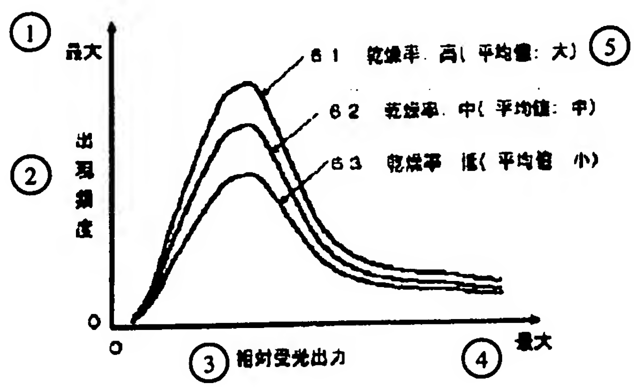


Figure 6

Key:
1 Maximum
2 Appearance frequency
3 Relative light-receiving output
4 Maximum
5 Dryness: higher (average value: larger)
Dryness: intermediate (average value: intermediate)
Dryness: lower (average value: smaller)

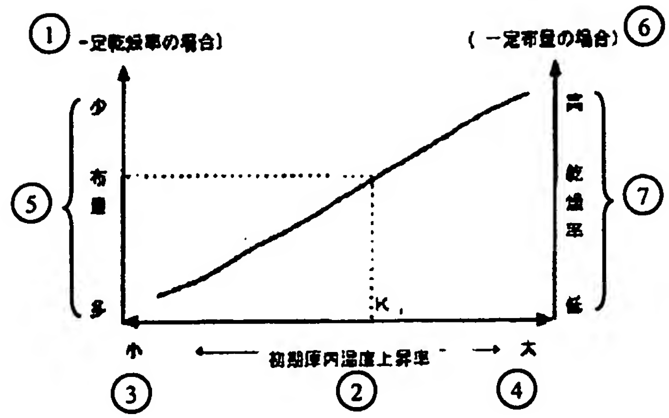


Figure 7.

Key:	1	(With constant dryness)
	2	Rise rate of temperature in the barrel
	3	Smaller
	4	Larger
	5	Smaller
		Clothes quantity
		Larger
	6	With constant clothes quantity
	7	Higher
		Dryness
		Lower